The TREND

IN ENGINEERING

at the University of Washington

In this issue:

New Projects, Engineering Research Dividends, New Reprints Available, Notes and Comments

These departments make up this limited issue. There will be no room for them in the July *Trend*, which is to be a special double issue to commemorate the Centennial Year at the University of Washington by reporting current research efforts in engineering.

April, 1961

Published quarterly

by

THE ENGINEERING EXPERIMENT STATION

NEW PROJECTS

The following twenty-five Engineering Experiment Station projects approved for the academic year 1960-61 are now in progress:

Reactivated Project No. 78. Microwave Tube Studies. Supervisor, A. E. Harrison, Professor of Electrical Engineering; Research Assistant, P. Nolan.

Project No. 297. Determination of the Al_2O_3ZrO Phase System. Supervisor, C. E. McNeilly, Assistant Professor of Ceramic Engineering; Research Assistant, R. E. Lyon.

Project No. 298. Disorder-Order Reaction Studies. Supervisor, E. C. Roberts, Professor of Metallurgical Engineering; Research Assistant, D. A. Bolstad.

Project No. 300. Derivation of a Stiffness Matrix for Large Deflections of a Rectangular Plate. Supervisor, E. H. Dill, Associate Professor of Aeroautical Engineering; Research Assistant, C. A. Lunder, Jr.

Project No. 301. Analog Simulation of Non-Steady State Fluid Flow Problems. Supervisor, K. L. Garlid, Assistant Professor of Chemical Engineering; Research Assistant, R. T. Cambio.

Project No. 303. Downstream Effect of Upstream Ablation. Supervisor, C. A. Sleicher, Jr., Associate Professor of Chemical Engineering; Research Assistant, L. H. Collins, II.

Project No. 304. Determination of Heat Transfer Coefficients for NaK in Concentric Tube Heat Exchanger. Supervisor, P. J. Waibler, Associate Professor of Mechanical Engineering; Research Assistant, J. P. Hawley.

Project No. 305. Design of a Variable Slope, High Velocity Water Channel. Supervisor, R. E. Nece, Assistant Professor of Civil Engineering; Research Assistant, S. C. Chu.

Project No. 306. An Evaluation of All-Way-Walk Signal Control. Supervisor, R. B. Sawhill, Associate Professor of Civil Engineering; Research Assistant, A. E. Krier.

Project No. 307. Vapor Growth of Semiconductor Devices. Supervisor, J. L. Bjorkstam, Associate Professor of Electrical Engineering; Research Assistant, D. R. Jackson.

Project No. 308. Nonlinear Control System Study. Supervisor, C. C. Hsu, Assistant Professor of Electrical Engineering; Research Assistant, V. Lum.

Project No. 309. Measurement of Solar Radio Energy for Correlation with Ionospheric Data. Supervisor, D. K. Reynolds, Professor of Electrical Engineering; Research Assistant, P. B. Bentley.

Project No. 310. Frequency Scanning Antennas. Supervisor, A. Ishimaru, Assistant Professor of Electrical Engineering; Research Assistant, H. S. Tuan.

Project No. 311. Study of Tie-Line Control Problems. Supervisor, F. R. Bergseth, Professor of Electrical Engineering; Research Assistant, H. Weischedel.

Project No. 312. Boiling Heat Transfer. Supervisor, C. P. Costello, Assistant Professor of Mechanical Engineering; Research Assistant, W. W. Clinton.

Project No. 313. Heater Failure. Supervisor, C. P. Costello, Assistant Professor of Mechanical Engineering; Research Assistant, E. Redeker.

Project No. 314. Speed Transition Analysis (Nonbraking) for Trucks in Commercial Service; and Development of Fuel Meter. Supervisor, J. C. Firey, Professor of Mechanical Engineering; Research Assistant, E. W. Peterson.

Project No. 315. An Electromechanical Analog Computer. Supervisor, P. L. Balise, Jr., Associate Professor of Mechanical Engineering; Research Assistant, D. Warne.

Project No. 316. Turbulent Heat Transfer to a Cooled Wall from a Super-Stream Flowing through a Small Channel. Supervisor, M. E. Childs, Associate Professor of Mechanical Engineering; Research Assistant, F. A. Gruenich.

Project No. 317. Calibration of Flow Parameters in Hypersonic Shock Tunnel. Supervisor, Wm. H. Rae, Jr., Assistant Professor of Aeronautical Engineering; Research Assistant, R. Ensminger.

Project No. 318. Slip Flow. Supervisor, R. E. Street, Professor of Aeronautical Engineering; Research Assistant, R. R. Iyer.

Project No. 319. Effect of Thickness of Backfill on Lateral Earth Pressures. Supervisor, R. H. Meese, Professor of Civil Engineering; Research Assistant, D. W. Grant.

Project No. 320. Thermal Stresses in Steel. Supervisor, D. D. Vasarhelyi, Associate Professor of Civil Engineering; Research Assistant, O. Ditman.

Project No. 321. Indeterminate Structural Analysis on IBM 709. Supervisor, B. J. Hartz, Associate Professor of Civil Engineering; Research Assistant, K. K. Kapur.

Project No. 322. A Study of Signal and Noise Correlation in Quantized Systems. Supervisor, E. Noges, Assistant Professor of Electrical Engineering; Research Assistant, D. G. Tubb.

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Engineering Research Dividends

Recent theses submitted for advanced degrees from the College of Engineering, University of Washington, will regularly appear in abstract form in *The Trend*. Complete copies of these theses are available for reference at the University of Washington Library. Address inquiries to the Director of the Engineering Experiment Station, University of Washington, Seattle 5.

CHANG, A. S., "Condensing Heat Transfer Coefficients inside a Sloping Tube," M. S. in Chemical Engineering, 1960.

An experimental investigation was carried out to determine the effect of angle of inclination on the condensing-heat transfer coefficients of pure n-propyl alcohol vapor at atmospheric pressure inside water-cooled tubes one and two feet long with ½-in. od by 0.298-in. id.

Tests made with the tubes inclined at angles of 0, 10, 20, 30, 40, 45, 50, 60, 70, 80, and 90 degrees to the horizontal and at approximately constant condensing rate for each condensing length showed that the condensing-heat transfer coefficients were affected by changing the angle of inclination. The maximum heat-transfer coefficient was obtained at an angle near 45° to the horizontal, this maximum being approximately 19% higher than that for a vertical tube and 13% higher than that for a horizontal one.

The results of this investigation were compared with the Nusselt theory for condensing vapor on vertical and horizontal tubes and with the equation derived in 1958 by K. E. Hassan and M. Jakob for vapor condensing on the outside of inclined cylinders. For the 1-ft tube the coefficients obtained in this investigation were approximately 35% lower than the values obtained through the Nusselt equation for the horizontal tube and agreed to within 2% with the corrected Nusselt equation for the vertical tube. For the 2-ft tube the coefficients were 67% lower than the values obtained through the Nusselt equation for the horizontal tube and 38% lower than those obtained by the corrected Nusselt equation for the vertical tube. For inclined cylinders the coefficients obtained in this investigation were 2 to 31% lower than the values predicted by the Hassan and Jakob equation for the 1-ft tube and 50 to 64% lower than predicted values for the 2-ft tube. The lower values of the experimental coefficients are attributed to the build up of condensate within the tube.

Attempts to correlate the experimental data were not successful since the effect of tube length could not be adequately expressed.

CHEN P. J., "Stress Analysis of Truncated Cones," M.S. in Engineering, 1960.

The state of stress and strain in a thin, truncated conical shell subjected to an arbitrary, smoothly distributed lateral pressure is determined. The shell is clamped at the large end and freely supported at the small end. It is assumed that the pressure is carried by membrane action except in regions near the supports. The complete solution is obtained by combining the membrane solutions with the solutions to the bending theory that applies near the supports. The special case of a nontruncated shell is also considered. The equations of Green and Zerna are used.

EATOUGH, N. L., "Equilibrium Studies of the System $Fe^{+++}-Ca^{++}-H^{+}-$Dowex 50W$-$X8," M. S. in Chemical Engineering, 1960.

The equilibrium distribution of ions in the system $Fe^{+++}-Ca^{++}-H^{+}-$Dowex 50W$-$X8 was measured at total solution concentrations of 1.0 and 2.0 N. Single ion-exchange particles and radioactive Fe^{59} and Ca^{45} tracers were used to obtain the experimental data by direct, relatively simple methods.

The individual particles of Dowex 50W$-$X8 exhibited little if any heterogeneity. The resin capacities were not a function of the solution composition or total solution normality, but the iron capacity was a function of the amount of iron hydrolysis in solution.

The ternary system may be considered as the combination of the three binary systems $Fe^{+++}-H^{+}$, $Ca^{++}-H^{+}$, and $Fe^{+++}-Ca^{++}$. Equilibrium distributions were determined for each binary system at fractions of the total solution concentration of 0.00, 0.10, 0.30 and 0.60 for the third ion not included in the given binary system. The binary equilibriums proceeded virtually independent of the concentration of the third ion in the ternary system, with the $Fe^{+++}-Ca^{++}$ exchange following a nearly linear equilibrium and both iron and calcium very much favored over hydrogen in the resin phase. The average mass-action equilibrium coefficients for the binary exchange systems are as follows:

$K_H^{Fe} = 4.2 \times 10^7$, $K_H^{Ca} = 11{,}300$, and $K_{Ca}^{Fe} = 500$.

The equilibrium distribution of ions in the $Ca^{++} - H^+$ and $Fe^{+++} - H^+$ systems at concentrations of the third ion of 0.60 of the total concentration showed considerable scatter in the experimental data because of the necessity of obtaining the hydrogen ion concentration in the resin by difference. However, the resin composition for these cases could be successfully computed by using the equilibrium coefficients determined from the pure binary systems. For these calculations it was necessary to use all three binary equilibrium coefficients and to avoid the use of powers of small concentrations that might introduce large errors into the results.

McLAUGHLIN, J. P., "Inducing Separation in Overexpanded Contour Rocket Nozzles," M. S. in Mechanical Engineering, 1961.

This is a report of an experimental investigation undertaken with the sponsorship of the University of Washington and the Boeing Airplane Company. The primary objective was to determine the effects of the insertion of step-rings in the diverging portion of an overexpanding supersonic rocket-motor nozzle.

An introduction to overexpanding nozzles, thrust coefficient, and flow separation is presented, as well as a complete description of the test configuration and the method of obtaining the test results.

This investigation showed that the thrust of a rocket motor with an overexpanding supersonic nozzle is increased up to at least five per cent by the insertion of properly designed rings in the diverging section. Under the effect of each ring, the thrust coefficient rose rapidly to a peak above the corresponding no-ring value and then fell off just as rapidly as the nozzle exit-to-ambient pressure ratio p_e/p_a increased.

These results and others are presented, their importance is discussed, and the applicability of the step-ring technique to modern rocket boosters is indicated.

MERRILL, M. H., "The Influence of Nuclear Radiation on Boiling Heat Transfer," M. S. in Engineering, 1960.

The object of the work was to investigate the effects of nuclear radiation on the mechanisms of boiling-heat transfer. Any such effects would have particular significance for types of nuclear reactors in which water is boiled in the core to produce steam. A survey of the pertinent literature indicates that nuclear radiation can produce vapor bubbles in water and other fluids under certain conditions of unusually high superheat and that they might do so in the core of a nuclear reactor. The investigation was made by using an electrically heated stainless-steel tube immersed in a pool of distilled water. The apparatus was operated over a range of heat fluxes from 7×10^3 to 2×10^5 Btu/hr ft^2 and was exposed during some of the tests to the radiation from four plutonium-beryllium neutron sources. With the sources present no effect was observed on the performance of the boiling-heat transfer. The neutron flux available in this experiment was very much less than that present in a nuclear reactor, and so it cannot be assumed that there would be no effect in the case of the reactor.

SAVERY, C. W., JR., "Reactivity Effects of Fuel Burnup in Nuclear Reactors," M. S. in Engineering, 1960.

The effects of fuel burnup upon reactor safety were investigated for a 20-mw reactor similar to the Argonne National Laboratory EBWR. Neutron diffusion, fuel isotope buildup, and reactor kinetics calculations were performed at 1000 mwd/ton intervals for a fuel-cycle duration of 4000 mwd/ton. The trend of the long-term effects of fuel burnup was found to be hazardous from the standpoint of reactor safety. However, the conclusion was that the effects were relatively slight for the reactor studied. Certain characteristics of reactor design greatly influenced the long-term effects of fuel burnup upon reactor safety. In systems with longer fuel cycles or higher initial conversion ratios, or both, the effects of fuel burnup would become more pronounced. Consequently, owing to the hazardous trend, these effects would be an important consideration for a designer of reactor control systems.

WALTON, IRVING, "A Surface Area Measuring Device Employing Continuous Gas Flow," M. S. in Ceramic Engineering, 1961.

A recently developed technique for the measurement of specific surface area of powders by the adsorption of nitrogen is presented. In this method, a stream of helium and nitrogen of known composition flows continuously over a sample cooled by liquid nitrogen. A quantity of nitrogen proportional to the surface area of the sample is adsorbed at the liquid-nitrogen temperature and desorbed when, upon removal of the coolant, the sample warms to room temperature. Nitrogen concentration is measured by a katharometer and graphically pictured as a peak on the strip-chart of a recording potentiometer. The area of the desorption peak, which is proportional to the quantity of nitrogen liberated, is measured with a planimeter. The method does not utilize fragile and complicated glassware or high-vacuum apparatus, but nevertheless is fast, sensitive, and simple. A determination including calculations can be made in ninety minutes.

Notes and Comments

A. L. Babb, Professor of Chemical Engineering, has been awarded two grants amounting to $77,600 for study and research related to the recovery of chemicals and the improvement of processes for recovering plutonium from the soil. One award, $55,200 from NSF, is for basic studies of chemical reactions occurring in the production of nitric acid; the other, $22,400 from AEC, is for work on solvent-extraction processes used at Hanford.

G. S. Schaller, Professor of Mechanical Engineering, received the Adams Memorial Membership Award of the American Welding Society. This first presentation of the national award went to Professor Schaller for his outstanding service to welding education.

E. H. Dill, Associate Professor of Aeronautical Engineering, is the author of a new NASA Technical Note, *General Theory of Large Deflections of Thin Shells.*

The Tenth Annual Motor Vehicle Maintenance Conference was conducted on March 20-23 by the College of Engineering. **F. H. Rhodes, Jr.,** Professor of Civil Engineering, made the arrangements for the conference.

In December **Dr. Joseph L. McCarthy,** Professor of Chemical Engineering and Dean of the Graduate School, received the Puget Sound Award in Chemistry, which is presented biennially to a chemist or chemical engineer from Washington, Oregon, Idaho, or British Columbia.

Robert G. Hennes, Professor of Civil Engineering, is one of the authors of *Federal Interest in Forest Highways,* a Highway Policy study published by the University. The work was issued in cooperation with the Bureau of Public Roads and the Washington State Highway Commission.

Akira Ishimaru, Assistant Professor of Electrical Engineering, presented two papers at the URSI-IRE meeting held in Boulder, Colorado, on December 12-14. For one of the papers, "Scattering by a Periodically Apertured Conducting Screen," acting instructor R. B. Kieburtz was the coauthor; for the other, "Closed Form Analysis for the Radiation Pattern of the Modulated Antenna," the coauthor was G. D. Bernard, graduate student.

Photographic glacial history is the subject of *Exploring Glaciers with a Camera,* a book by **Arthur E. Harrison,** Professor of Electrical Engineering. This volume, which has excellent samples of Professor Harrison's technique, was sponsored by the Sierra Club of California.

G. L. Hollingsworth, Director, Boeing Scientific Research Laboratory, is to be the speaker at the general session of the Pacific Northwest Section of ASEE meeting at the University on May 5-6.

R. O. Sylvester, Professor of Sanitary Engineering, and **D. A. Carlson,** Assistant Professor of Civil Engineering, have been granted $19,993 by the Army engineering corps to carry out a water-quality surveillance program for the Howard A. Hanson impoundment at Green River, Washington. The purpose of the study is to discover the possible effects on the Tacoma water supply of water impoundment over a swamp.

ROAD BUILDERS MEET

The 1961 Northwest Conference on Road Building and Traffic Engineering was held in More Hall on February 15, 16, and 17. Highlighting the conference were papers on growth of cities, urban planning, and transportation studies. These topics are currently of special interest in the Northwest because of the comprehensive Puget Sound Regional Transportation Study, which is just now getting started under the able guidance of its director, John Mladinov.

Another important feature of the program was the session directed toward aids to cities of all sizes in handling their problems of traffic, urban renewal, and planning. Cities and towns in Washington face the need to finance street improvements, but the revenues currently available are inadequate, and effective planning becomes a must in finding a solution to the problem. Martin Ekse, *Professor of Civil Engineering, Conference Chairman.*

NEW REPRINTS AVAILABLE

Reprint No. 174. "Triaxial Compression Tests on Soils Using Variable Lateral Pressure." R. H. Meese and R. W. Long, *Spec. Tech. Publ. 254,* Amer. Soc. for Testing Materials, 1959.

Reprint No. 175. "A Test for Production of Plastic Fines in the Process of Degradation of Mineral Aggregates." M. I. Ekse and H. C. Morris, *Spec. Tech. Publ. 277,* Amer. Soc. for Testing Materials, 1959.

Reprint No. 176. "Some Influences of Multi-Purpose Water Usage on Water Quality." R. O. Sylvester, *Athens Proceedings of the I.U.C.N. Technical Meeting,* Vol. IV, 1959.

Reprint No. 177. "Some Mathematical Aspects of the LaPlace Transformation." P. L. Balise, *Conference Preprint No. 6-59,* Instr. Soc. of Amer., 1959.

PUBLICATIONS

of the

ENGINEERING EXPERIMENT STATION

UNIVERSITY OF WASHINGTON

Requests for copies of publications should be addressed to the Director, Engineering Experiment Station, University of Washington, Seattle 5.

BULLETINS

48. The Influence of Pipe Thickness on Re-Entrant Intake Losses. Charles William Harris. 33 pp. 1928.
54. Elimination of Hydraulic Eddy Current Loss at Intake. Charles William Harris. 30 pp. 1930.
55. Vacuum-Tube Control for Electric Wind-Tunnel Balances. Fred S. Eastman. 20 pp. 1931.
56. Constant Flow Characteristic of the Plane Orifice in Proximity to Side Walls. Charles William Harris. 18 pp. 1931..
58. Preliminary Tests of Thirteen Washington Coals in a Powdered Coal Boiler Plant at the University of Washington. George Samuel Wilson, Harry Fagan Yancey, and Joseph Daniels. 27 pp. 1931.
60. An Electromagnetic Balance for Force Measurement of Current Control. Fred Scoville Eastman. 29 pp. 1932.
61. Hydraulic Flow Characteristics of a Square-Edged Intake. Charles William Harris. 21 pp. 1932.
67. The Doherty Washer Cooler, Sybren Ruurd Tymstra. 61 pp. 1932.
72. The Derivation of the Mean Temperature Difference Between a Saturated Gas and a Cooling Liquid, and also the Derivation of the Mean Velocity of Such Gas. Sybren Ruurd Tymstra. 19 pp. 1933.
74. The Deformation of Hard Grade Reinforcing Steel During and After Construction in a Reinforced Concrete Building. Sergius Ivan Sergev. 33 pp. 1933.
75. The Water Tube Gas Condenser. Sybren Ruurd Tymstra. 24 pp. 1934.
76. Kaolin and China Clay in the Northwest. Hewitt Wilson. 184 pp. 1934. (Loan only.)
77. A Study of Fundamental Relations of the Mathematical Theory of Elasticity. Arthur Melvin Winslow. 25 pp. 1934. (Loan only.)
81. Influence of Two Secondary Factors in Weir Measurement. Charles William Harris. 16 pp. 1935.
85. Discharge of Three Commercial Cippoletti Weirs. Robert Bowman Van Horn. 32 pp. 1935.
87. Open Water Testing of Ship Models. Thomas McKie Rowlands. 20 pp. 1935.
88. The Properties of Quartz Sands Washed from Kaolins of the Pacific Northwest. Hewitt Wilson and Frank Joseph Zvanut. 42 pp. 1936.
91. The Analysis and Control of Landslides. Robert Graham Hennes. 57 pp. 1936. (Loan only.)
92. Moment Equations. A Method of Analysis for Continuous Beams and Rigid Frames. Alfred Jensen. 88 pp. 1937.
94. Evaporation and Surface Cooling. George Samuel Wilson and William Lyle Dudley. 18 pp. 1937.
98. Geology and Its Relation to the Occurrence of Oil in Washington. Charles Edwin Weaver. 16 pp. 1938.
100. Modernization of a Transit System. Factors that Determine the Choice of a Vehicle. George Lisle Hoard. 36 pp. 1940.
101. Buckling Criteria and Design of Two-Story Columns. Sergius I. Sergev. 48 pp. 1940.
102. An Investigation of Prestressed Stays. T. M. Rowlands and F. C. Smith. 36 pp. 1941.
103. Bismuth Bridge Magnetic Flux Meter. George Sherman Smith. 48 pp. 1940.
104. The Telechronometer, Telephone Service Measurement in Units of Time. Lyall Baker Cochran. 68 pp. 1941.
106. The Shearing Strength of Cement Mortar. Frederick C. Smith and Robert Q. Brown. 32 pp. 1941. (Loan only.)
108. Silica Sands of Washington. Hewitt Wilson, Kenneth C. Skinner, and Albert H. Couch. 76 pp. 1942.
109. The Number of Teeth in Contact as a Vibration Factor in Involute Cut Gears. Sybren Ruurd Tymstra. 16 pp. 1942.
110. Solutions for Torsional Vibration Frequencies by Energy Method. Arthur Melvin Winslow. 22 pp. 1943.
111. Stabilized Earth Blocks for Protective Construction. Robert G. Hennes. 24 pp. 1943.
112. Hydraulic Models. Charles W. Harris. 17 pp. 1944.
113. The Theoretical Behavior and Design of Initially Curved Struts Under an Intermediate Concentric Axial Load. Sergius I. Sergev. 32 pp. 1945.
114. The Effect of Shearing Forces on the Deflection and Strength of Beams. Sergius I. Sergev. 20 pp. 1947.
116. Aerodynamic Stability of Suspension Bridges with Special Reference to the Tacoma Narrows Bridge. Part I. Investigations Prior to October, 1941. F. B. Farquharson. 103 pp. 1949. (Loan only.)
116. Aerodynamic Stability of Suspension Bridges with Special Reference to the Tacoma Narrows Bridge. Part II, Mathematical Analyses. F. C. Smith and G. S. Vincent. 63 pp. 1950.
116. Aerodynamic Stability of Suspension Bridges with Special Reference to the Tacoma Narrows Bridge. Part III, The Investigation of Models of the Original Tacoma Narrows Bridge Under the Action of Wind. F. B. Farquharson. 125 pp. 1952.
116. Aerodynamic Stability of Suspension Bridges with Special Reference to the Tacoma Narrows Bridge. Part IV. The Investigation of Models of the New Tacoma Narrows Bridge Under the Action of Wind. F. B. Farquharson. 104 pp. 1954.
116. Aerodynamic Stability of Suspension Bridges with Special Reference to the Tacoma Narrows Bridge. Part V, Extended Studies: Logarithmic Decrement, Field Damping, Prototype Predictions, Four Other Bridges. G. S. Vincent. 104 pp. 1954.
118. Investigations in Aeronautics from the Department of Aeronautical Engineering. Edited by R. M. Rosenberg. 120 pp. 1951.
119. The Extremum Principles of the Mathematical Theory of Elasticity and Their Use in Stress Analysis. (The Walker-Ames lectures of the Spring Quarter, 1950.) W. Prager (Brown University). 30 pp. 1951.

REPORTS

2. Iron and Steel Manufacture in Washington, Oregon, California, and Utah. Joseph Daniels. 69 pp. 1929. (Loan only.)
3. Coal in Washington. Joseph Daniels. 17 pp. 1934. (Loan only.)
4. Water Resources of Washington. Richard Gaines Tyler. 61 pp. 1938 (Loan only.)
7. A Natural Uranium-Graphite Subcritical Reactor System for Education and Research. Part I. Description and Experimental Measurements. A. L. Babb, L. Grimsrud, W. E. Wilson. Part II. IBM 650 Computer Programs for Effective Size, Diffusion Length, and Material Buckling Calculations. A. L. Babb, L. Grimsrud, S. Tashiro. 33 pp. 1959.

TECHNICAL NOTES

3. The Theory of Fractional Parts Developed for Structural Beam-Column Members Preceded by an Elementary Discussion of Simple Beam and Column Design. Sybren Ruurd Tymstra. 32 pp. 1934. (Loan only.)
4. Gaging Chart for Horizontal Cylindrical Tanks with Flat Heads or with Convex Heads. Sybren Ruurd Tymstra. 4 pp. 1944.
5. Gaging Chart for Cylindrical Tanks with Different Types of Heads. Sybren Ruurd Tymstra. 7 pp. 1945.

TREND REPRINTS AVAILABLE

T3. A New Critical Phase of the Lake Washington Pollution Problem. R. O. Sylvester, W. Thomas Edmondson, R. H. Bogan 7pp. 1956.

T8. Who's Going to Teach Them and How. Editorial Study. 2 pp 1957.

T9. A Model Study of Some Fish Facilities for the Proposed Mayfield Dam. Part I: The Skimmer. E. P. Richey and H. H. Chenoweth. 8 pp. 1957.

T12. Professional Ethics and Engineering Education. A Arthur Hemenway. 1 p. 1958.